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A Review on Design Analysis and Optimization of Centrifugal Casting Machine Shaft

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ABSTRACT*: The paper review various research works carried out through design analysis and optimization of various types of shafts .The research contributes to the problem evaluation of a small scale industry working in the area of casting. The research based on shaft failure, shaft optimization and different material using of the shaft of different machine and automobile industries. This could help the industries working in these areas to improve the life and function ability of the unit which would in their term lead to higher productivity. This literature tries to diagnosis the reason failures optimization technique and would suggest the composite material in the same regards. The proposed works not only design analysis but also optimization of computerized techniques to evaluate deflection, stress analysis. This, in turn will decide the criteria of material selection and dimensional parameters. Thus, the work contributes to reduction of weight of casting machine, reduction of the manufacturing cost and delivers better result.*

Keywords: *Shaft, optimization, design, composite material, deflection, stress, etc.*

I. Introduction

Centrifugal casting is an advanced slip casting technique; which can be used for casting a body which has axial symmetry. This method is commonly used in casting of molten metal, but it can be used in casting of slurry which contains ceramic powder. The method involves pouring of molten metal into a cylindrical mould rotating about its axis of symmetry. In this method of casting, it involves rotating the mould in a horizontal axis. A typical horizontal centrifugal casting machine is as shown in fig 01and fig 2. Horizontal centrifugal casting is preferred for the tube geometry as the diameter for such geometry is less than their length. In centrifugal casting machine drive shaft is most important component to run the application, because of failure of shaft tends to stop the production line of the components.

A drive shaft is a rotating shaft that transmits power from the motor to the shaft with the help of chain and sprocket. Drive shaft must operate in high initially torque the centrifugal casting machine is old process and also some companies carry old process the optimization is very important and reduction of the weight of the shaft is very important in this paper study the existing shaft design analysis and study the failure point for the new invention or generation of the new shaft design.

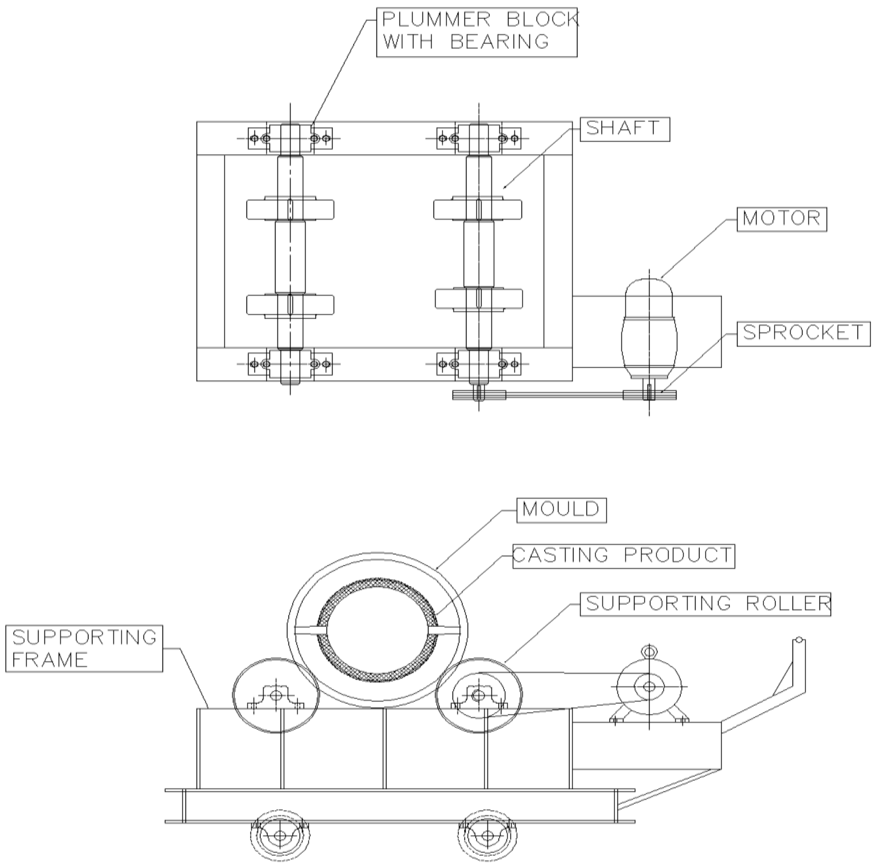

Fig. 01. Schematic diagram of centrifugal casting machine.

Fig. 02. Centrifugal casting machine shaft with roller (On site Photograph)

II. Problem Formulation: Need And Significance Of Proposed Research Work

In the centrifugal casting industries, where old type casting techniques are used; shaft failure and bearing failure are the frequent problems encountered along with wear. This results to uncertain failure of machine spares which leads to subsequent breakdowns, increasing the running cost and reducing the productivity. The frequency of breakdowns due to uncertain failure and the cost incurred for the repair/replacement in high which increases the running cost of the industry. The current machine they are using is too much heavy and single machine they are using for the single casting the product also the one machine operation having four people work so the indexing type casting machine is new invention, at the single machine having eight machine and the total eight machine operate only four people at this new concept the machine components is also optimized and light weighted. Major component of the machine is shaft optimization with new design.

III. Literature Review

R.P Kumar Rompicharlal, Dr, K.Rambabu[1] in this paper The usage of composite material has resulted to inconsiderable amount of weight saving in the range of 28 % when compared to conventional steel shaft .Taking into considerations the weight saving, deformation, shear stress induced and resonant frequencies it is evident that Kevalar/Epoxy composite has the most encouraging properties to act as replacement for steel out of the considered two materials .The presented work was aimed to reduce the fuel consumption of the automobile in the particular or any machine, which employs drive shafts ,in general it is achieved by using light weight composites like Kevelar/Epoxy

V. S. Khangar and Dr. S. B. Jaju [2]The various methodologies used for the failure analysis of shaft used in different application by various authors are reviewed in this paper. Roll shaft failure can be prevented primarily by introduction of better material design optimization & by using correct manufacturing processes. This paper presents the comparison of the different methodology used, their application & limitation by various authors.The objective of the present work is to study the various methodologies used for the shaft failure analysis & to choose the best methodology suitable for the failure analysis of bridle roll shaft used in continuous steel industry to prevent repetitive failure. Bridle roll failure leads to heavy loss approximately Rs 80000 per hour due to line stoppage & repairing cost associate with the breakdown.

S. M. Ghoneam1, a, A. A. Hamada1, b and M. I. EL-Elamy1, [3] “DYNAMIC ANALYSIS OF A ROTATING COMPOSITE SHAFT” the dynamic analysis of a rotating composite shaft. The numerical finite element technique is utilized to compute the eigen pairs of laminated composite shafts. A finite element model has been developed to formulate the stiffness matrices using lamination theory. These matrices take into account the effects of axial, flexural and shear deformation on the eigen-nature of rotating composite shaft.The Campbell diagram is utilized to compute the critical speed of rotating composite shaft and instability regions to achieve accuracy and for controlling the dynamic behaviour of the system in resonance state. The influence of laminate parameters: stacking sequences, fiber orientation, boundary conditions and fiber volume fractions effect on natural frequencies and instability thresholds of the shaft arestudied. The results are compared to those obtained by using the finite element method and experimental measurements using frequency response function method (FRF) by applying the autogenously excitation. In the experimental part, the response of composite shaft with various types of boundary conditions and five lamina orientations were recorded and analyzed by utilizing fast Fourier transform dual channel analyzer in conjunction with the computer. The comparison between the numerical and experimental results proves that the suggested finite element models of the composite shaft provide an efficient accurate tool for the dynamic analysis of rotating composite haft.

EuricoSeabra (p) Joaquim Barbosa HélderPuga[4] “Design and development of a centrifugal casting

machine for pistons production” A possible solution might be a well-controlled sequential pouringtechnique of different materials that lead to a smooth gradient of composition/properties between different piston functional areas, using centrifugal casting. For this purpose a special design of a vertical axis centrifugal casting machine was developed. A detailed study of the centrifugal pouring process and the inherent fluid dynamics was performed to develop a conceptual design and operation parameters and input/output system variables were established.

Sagar R Dharmadhikari, 1 Sachin G Mahakalkar, 2 Jayant P Giri, 3 Nilesh D Khutafale4 [5]“Design and Analysis of Composite Drive Shaft using ANSYS and Genetic Algorithm” A Critical Reviewin this paper The replacement of conventional drive shaft results in reduction in weight of automobile by finite element analysis is used in this work to predict the deformation of shaft.The deflection of steel, HS Carbon / Epoxy and HM Carbon / Epoxy shafts was 0.00016618, 0.00032761 and 0.0003261 mm respectively. Natural frequency using Bernoulli – Euler and Timoshenko beam theories was compared. The frequency calculated by Bernoulli – Euler theory is high because it neglects the effect of rotary inertia & transverse shear. Hence the single piece High Strength Carbon / Epoxy composite drive shaft has been proposed to design to replace the two piece conventional steel drive shaft of an automobile.

AsmamawGebresilassie,[6] “Design and analysis of Composite Drive Shaft for Rear-Wheel Drive Engine” inthis paper study of composite shaft, Composite shaft made from E-Glass/ Epoxy is investigated theoretically and numerically by taking torsion load. To analyse the shaft using FEA the composite shaft is fixed from one end and the torque is applied to the other end. For numerical study, when theFinite Element Analysis results compared with the theoretical results, the observations and study carried on the topic is successful and yield very small variations from the expected results.

M. Zamanzadeh, E. Larkin and D. Gibbon; [7] in these paper the author presents the methods of various failure analysis processes applied to all different types of materials. Each class of materials requires special skills and experience to effectively unravel the causes of failure. This paper focuses on these various subsets of materials.These include failures in metallurgy, paints and coatings, plastics and electronics, as well as failure caused by corrosion and principles of root cause determination within that particular field. This paper is primarily concerned with the overall approach to failure analysis and with the applications of that approach to metallurgical failures. In these paper various case studies on materials failure analysis are reviewed.

R. A. Gujar1, S. V. Bhaskar2[8] "Shaft Design under Fatigue Loading by Using Modified Goodman Method"in this paper the study of goodman method and behaviour of dynamic shaft also the fatigue life prediction is performed based on finite element analysis and analytical method. Using the constant amplitude loading, the fatigue life of the dynamometer shaft has been predicted. This study will help to understand more the behavior of the dynamometer shaft and give information for the manufacturer to improve the fatigue life of the dynamometer shaft using FEA tools. It can help to reduce cost, critical speed and times in research and development of new product.

S Sreenatha Reddy, Dr V Pandurangadu and I Srinivas [9] "Studies on the effect of compression ratio and speed on oil recovery and energy consumption in mini oil expeller for Pongamia and Jatropha seed oil expulsion" in this paper a mini oil expeller is fabricated to find out the effectof variation in compression ratio of the oil chamber and speed of the screw shaft on oil recovery and energyconsumption during oil extraction of Pongamia and Jatropha seeds A mini oil expeller is fabricated byincorporating the adjustments for variation in compression and speed. During the experiment, the compressionratio is changed from 14:1 to 21.5:1, and the speed is altered from 35 rpm to 65 rpm. The interactive effect ofthese two parameters on oil expulsion is observed critically and compared with the conventional expeller. Compression ratio has shown significant impact on oil recovery and energy consumption.

Ali Vaziri1, Prof. M. J. Patil2, [10] "Vibration Analysisofa Cracked Shaft"in this paper the detection of cracks in shafts by measuringthe change s in an adequate number of thenatural frequencies has been considered in thispaper. A crack is known to introduce local flexibilityin the shaft. The local flexibility due to a crack inthe presence of bending moment and shear loads ismodelled by using fracture mechanics concepts.Cracks are then predicted by measuring anadequate number of shaft natural frequencies. The adequate number of natural frequencies that needs tobe measured depends on the number of cracks present.

IV. Methodology

4.1 Design and validation of dimension of shaft and roller consider e.g. Casting mould and roller with shaft assembly through Reverse Engineering: Casting drum size having some kind of guide and the changing of the mould is costly, the optimization of the existing shaft considering the mould sizing with the reference to collection of existing data and model will be prepared of designed Analysis of the old design with the help of numerical calculation and modelling software and the new dimensional design will be compared with traditional method as well as numerical calculation and modelling software of design engineering.

4.2 Evaluation of Existing Design: The casting machine system which already in exist and existing shaft evaluation will be done by measuring the actual working load ,bearing temperature and analyzing its effect on various like main shaft, roller ,bearing by simulating and testing the model using ANSYS with the actual constraints.

4.3 Evaluation of deflection and stress analysis through computerized techniques and optimization of shaft : The FEM analysis is proposed for deflection and stress evaluation of the designed optimized main shaft, roller by applying the similar constraint with respect to material, force and loading conditions, to determine the high stressed regions and maximum deflection .After stress deflection analysis decision about changes which could be in dimensions and material will be taken in order to make the optimal changes to reduce the failures.3

4.4 By comparing the both results, according to the result of stress, deflection by numerical and computerised method and validation of the optimized shaft on centrifugal casting machine.

V. Future Work

The replacement of conventional casting machine shaft results in reduction in weight of the machine. The finite element analysis is used in this work to predict the deformation and stress analysis of shaft. Design analysis of the existing shaft also new optimized shaft with comparing the both results, validation of the optimized shaft on centrifugal casting machine. The results of the work are encouraging and suggest the replacement of conventional drive shaft. This paper is useful in the earlier stages of the development, saving development time and helping in the decision making process to optimize a design, before going into a detailed finite element analysis.

VI. Conclusion

6.1 After completing future work scope of result is; the replacement of conventional casting machine drive shaft results in reduction in weight of machine and optimization of the shaft.
6.2 The finite element analysis is used in this work to predict the deformation of shaft.
6.3 The results of the work are comparing both existing shaft and modified shaft suggest the replacement of conventional drive shaft

References

[1] R.p Kumar Rompicharlal, Dr, K.Rambabu,"Design and Optimization of Drive Shaft with Composite Material "2002by EuricoSeabra Joaquim Barbosa HélderPuga .2003
[2] V. S. Khangar, Dr. S. B. Jaju,(2012) "A Review of Various Methodologies Used for Shaft Failure Analysis", International Journal of Emerging Technology and Advanced Engineering,ISSN 2250-2459, Volume 2, Issue 6, June 2012.
[3] S. M. Ghoneam1, a, A. A. Hamada1, b and M. I. EL-Elamy1, c "Dynamic Analysis of a Rotating Composite Shaft"Menoufiya University, Shebin El-Kom, Egypt.
[4] BarbosaHélder."Design and development of a centrifugal casting machine for pistons production "by EuricoSeabra Joaquin Barbosa HélderPuga .2003
[5] Sagar R Dharmadhikari, 1 Sachin G Mahakalkar, 2 Jayant P Giri, 3 Nilesh D Khutafale4 "Design and Analysis of Composite Drive Shaft using ANSYS and Genetic Algorithm"International Journal of Modern Engineering Research (IJMER)Vol.3, Issue.1, Jan-Feb. 2013 pp-490-496 ISSN: 2249-6645
[6] AsmamawGebresilassie, "Design and analysis of Composite Drive Shaft for Rear-Wheel Drive Engine" International Journal of Scientific & Engineering Research 1 ISSN 2229-5518Volume 3, Issue 5, May-2012
[7] M. Zamanzadeh, E. Larkin and D. Gibbon,(2004),Case study on"A Re-Examination of Failure Analysis and Root Cause Determination", Pittsburgh, Pennsylvania 15244412-788-1263 December 2004.
[8] R. A. Gujar1, S. V. Bhaskar2 " Shaft Design under Fatigue Loading By Using Modified Goodman Method" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 3, , pp.1061-1066, Issue 4, Jul-Aug 2013
[9] S Sreenatha Reddy, Dr V Pandurangadu, and I Srinivas,(2010)" Studies on the effect of compression ratio and speed on oil recovery andenergy consumption in mini oil expeller for Pongamia and Jatropha seed oil expulsion", eNREE A quarterly electronic newsletter onrenewable energy and environment,volume 7,issue 2 April–June 2010.
[10] Ali Vaziri1, Prof. M. J. Patil2,VIBRATION ANALYSIS OF A CRACKED SHAFT Vaziri, International Journal of Advanced Engineering Technology E-ISSN 0976-3945 IJAET/Vol. IV/ Issue II/April-June, 2013/103-104